SECTION 16484
VARIABLE FREQUENCY MOTOR DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Digital pulse-width-modulated drives for variable speed control of standard three-phase AC induction motors, rated to provide 10 to 100 percent of the drive horsepower rating in a continuous range of operation.

B. Related Sections
   1. Section 16191, Supporting Devices
   2. Section 16196, Electrical Identification
   3. Section 16450, Grounding

1.3 REFERENCES

A. ETL Testing Laboratories, Inc. (ETL):
   1. ETL Report – "Procedures for Test of Variable Frequency No. 496989 Drives".

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   1. IEEE 74 – "Test Code for Industrial Control (600 Volts or Less)"
   2. ANSI/IEEE 518 – "Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources" (copyrighted by IEEE, ANSI approved)
   3. IEEE 519(1992) – “Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems”
   4. IEEEE C37.121 – “American National Standard for Switchgear and Unit Substations”

C. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250 – "Enclosures for Electrical Equipment (1000 Volts Maximum)" (copyrighted by NEMA, ANSI approved).
   2. NEMA ICS 1– "General Standards for Industrial Controls and Systems" (copyrighted by NEMA, ANSI approved).
   3. NEMA ICS 2 – "Industrial Control Devices, Controllers and Assemblies" (copyrighted by NEMA, ANSI approved).
   4. NEMA ICS 3 – "Industrial Systems" (copyrighted by NEMA, ANSI approved).
   5. NEMA ICS 3.1– "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems".
   6. NEMA ICS 4– "Terminal Blocks for Industrial Use" (copyrighted by NEMA, ANSI approved).
   7. NEMA ICS 6 – "Enclosures for Industrial Control and Systems" (copyrighted by NEMA, ANSI approved).

D. National Fire Protection Association (NFPA):
   1. NFPA 70 1999 – "National Electrical Code" (copyrighted by NFPA, ANSI approved) - hereinafter referred to as NEC.

E. Underwriters Laboratories, Inc. (UL):
   1. UL 294 – "UL Standard for Safety - Access Control System Units" (copyrighted by UL, ANSI approved).
   2. UL 486A – "UL Standard for Safety - Wire Connectors and Soldering Lugs for Use with Copper Conductors".
   3. UL 508 – "UL Standard for Safety - Industrial Control Equipment" (copyrighted by UL, ANSI approved).

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's product data showing material proposed. Product data shall include, but shall not be limited to, the following:
   1. Horsepower.
   2. NEMA size.
   3. Dimensions.
   4. Voltage (shall be 480volt).
   5. Phase (shall be three phase).
   6. Circuit breaker type.
   7. Heater type and sizes.
   8. Starter type, size and manufacturer.
   9. Control transformer.

B. Shop Drawings: Submit complete shop drawings as required to determine acceptability. Shop drawings shall include, but shall not be limited to, the following:
   1. Wiring diagrams.
   2. Overcurrent protection.
   3. Connection to and location of starters.
   4. Auxiliary contacts, type and quantity.
   5. Control devices, switches, panel lights, and timers.
   6. Display setup, options, programming and features.

C. Operating and Maintenance Manuals: Prepare and deliver five complete operating and maintenance manuals. Provide information pertinent to the equipment for preventive maintenance and for replacement of expendable components. Provide complete and explicit instructions for start-up, operating, and stopping. Manuals shall include the items listed below and other information recommended by the manufacturer:
   1. Manufacturer's published information.
   2. Set of shop drawings.
   3. Wiring diagrams of electrical components.
   4. Electrical characteristics and ratings components.
   5. Recommended spare parts list.
   6. Complete list of parts.

D. Harmonic Analysis: The variable frequency drive (VFD) manufacturer shall certify that the drives shall meet the requirements of IEEE-519, 1992 edition for the total harmonic voltage and current distortion. Simultaneous operation of all drives included herein shall not add more than 5% total harmonic voltage and current distortion to the bus.
   1. The utility transformer at the main substation shall be the current distortion point of common coupling. The drawings showing distances and system configuration are included herein. The maximum allowable total and individual harmonic current distortion limits for each VFD shall not exceed the limits set forth by IEEE 519, 1992.
   2. A preliminary detailed harmonic analysis must be submitted by the VFD manufacturer at bid time, which includes all harmonic to the 99^{th}. Compliance shall be verified by the VFD manufacturer with field measurements of the harmonic distortion difference at the point of common coupling with and without the VFDs operating.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms shall be engaged in the manufacture of alternating current variable frequency drives of the types and sizes required, and whose products have been in satisfactory use in similar service for not less than five years.
   1. The manufacturer shall furnish a list of users of similar design systems, using the exact same motor listed in the recommended motor supplier list, with records of maintenance and operation.
   2. The variable speed drives with all accessories and features shall be assembled and tested by the variable speed drive manufacturer in his factory.

B. Compliance: Comply with applicable requirements of ETL, IEEE, NEMA, and UL standards referenced in Article 1.3 - References, and the NEC.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and handle variable frequency drives carefully to avoid damage to materials and components. A portion of the drives shall be delivered to the jobsite. The remainder shall be delivered to various equipment manufacturers factories for equipment testing requirements.

PART 2 - PRODUCTS

2.1 Variable frequency motor drives are included as part of the directed procurement program for this project. The Construction Manager is administering the program and equipment shall be purchased in accordance with program requirements.

PART 3 - EXECUTION

3.1 APPLICATION

A. The manufacturer shall provide listings of acceptable and approved motor manufacturers and models applied to the same type load that the variable frequency drive is matched to and has been in successful operation with, for at least five (5) years.

3.2 FIELD QUALITY CONTROL

A. Upon completion of the installation the manufacturer’s trained field service engineer or technician shall commission each drive. In the presence of the construction manager on site, the following data shall be documented for each drive:
   1. Input amperage.
   2. Minimum speed setting.
   3. Maximum speed setting.
   4. Motor current at minimum and maximum speed.
   5. Volts per hertz minimum and maximum speed.
   6. Document all settings.
   7. Any critical speeds to be avoided.
   8. Recommended ramp up and ramp down speeds.

3.3 TESTING AND START-UP

A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

B. The manufacturer shall furnish start-up assistance during system commissioning. The field service shall include, but shall not be limited to, initial operating control settings and multiple start/stop and power loss simulations.

C. The manufacturer shall provide final visual inspection and cleaning of internal components and exterior cabinet.

3.4 TRAINING

A. Provide the services of a factory trained technician to instruct the owner's personnel in the operation, startup and maintenance of all drives provided. Training time shall be not less than 8 hours and not more than 16 hours on each different type of drive provided.

3.5 WARRANTY AND AN OPTIONAL SERVICE CONTRACT

A. The VFD shall be warranted by the manufacturer for a period of 24 (twenty four) months from date of certified start up. The warranty shall include parts, labor, travel cost and living expenses incurred by the manufacturer to provide factory authorized on-site service.

B. Manufacturer shall include with the bid, as an option, a price for a three year service contract, that starts the day the warranty expires. The service contract shall be through a manufacturer's certified company that is located within 100 (one hundred) miles from this site.

END OF SECTION 16484